March 20, 1962 A. AZAN 3,026,410

PRE-STABILIZED COLD CATHODE LIGHT SOURCE

Filed Feb. 7, 1958 2 Sheets-Sheet 1

Fig. 1.

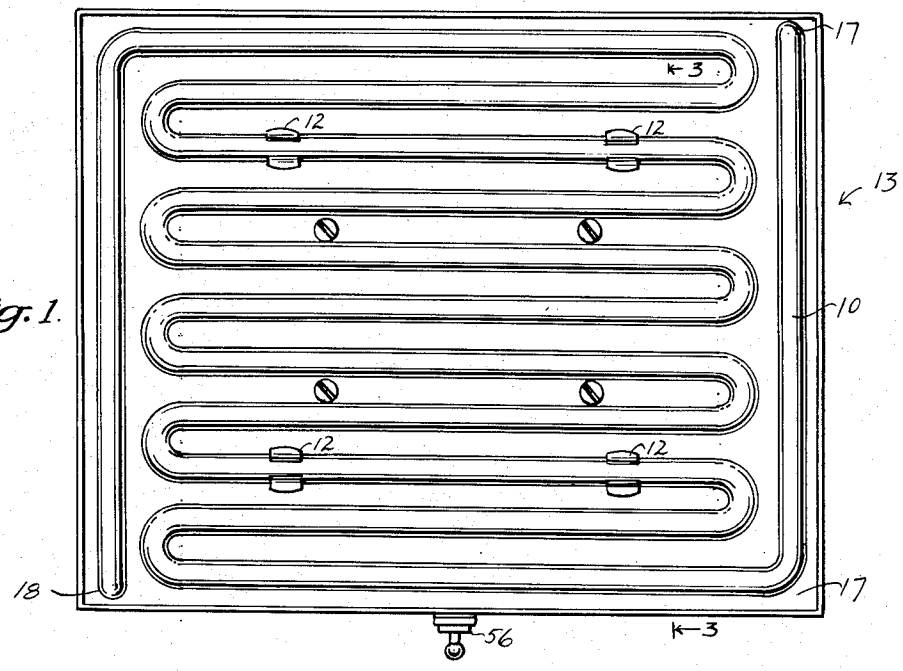
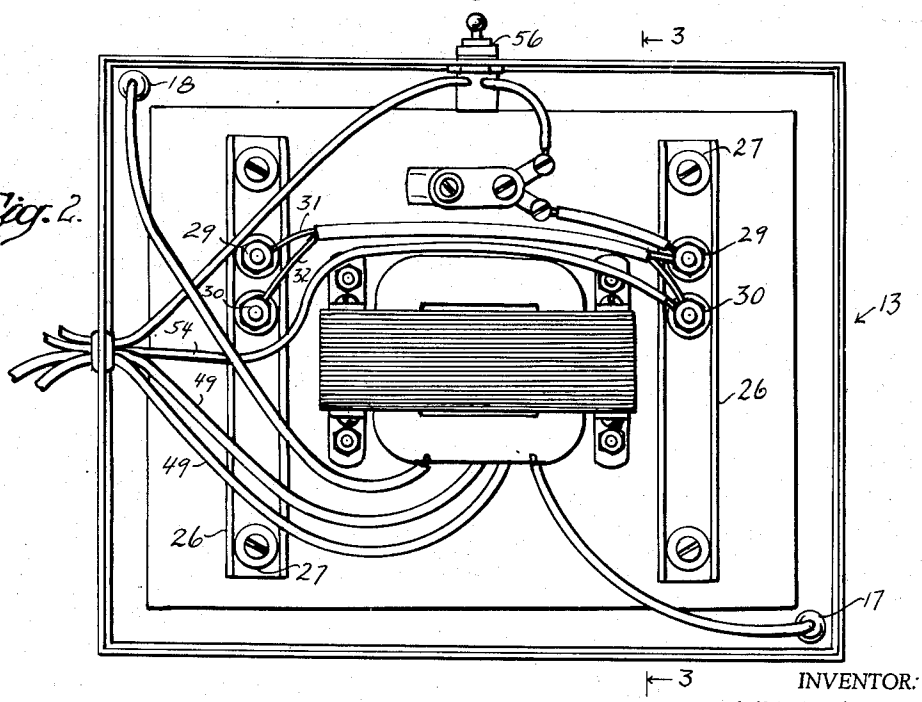


Fig. 2.



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Fig. 3.

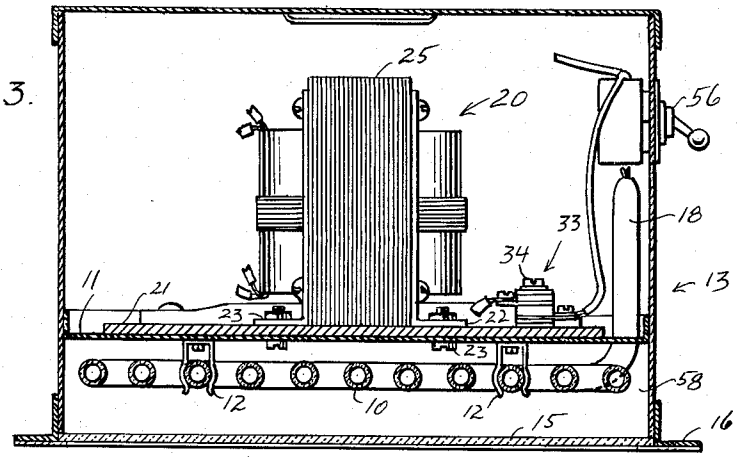
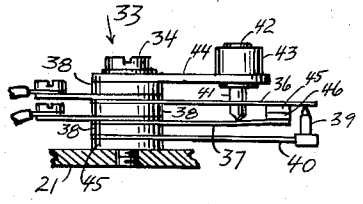


Fig. 4.



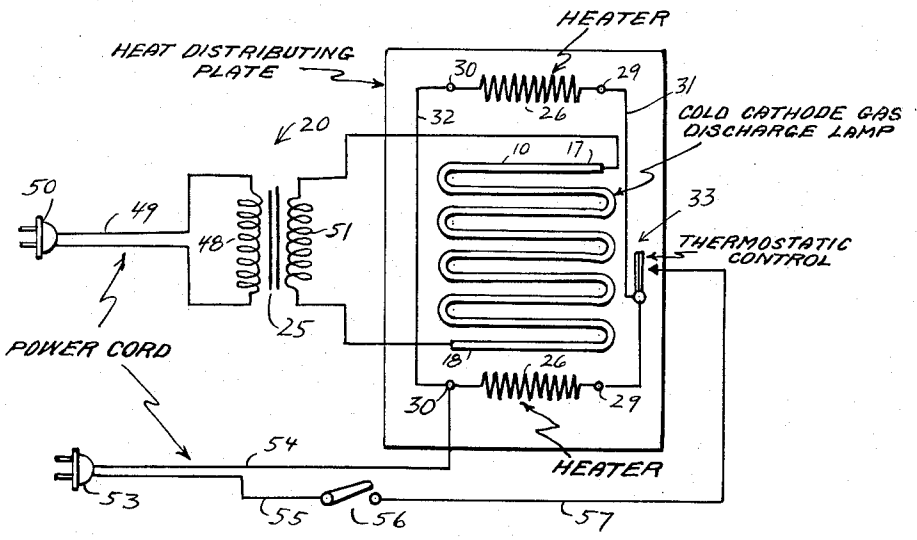


Fig. 5.

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3,026,410 PRE-STABILIZED COLD CATHODE LIGHT SOURCE

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7 Claims. (Cl. 240—11.4)

The present invention relates to a prestabilized cold cathode light source for photographic purposes and more particularly to a light source which is temperature stabilized so that it may be turned on or off for immediate use whenever desired without any need to wait during a warming up period before the light source is ready for use.

The light source of the present invention is suitable for use with enlarging cameras and similar photographic equipment where a light source is needed which is of high intensity and which is also of high stability both in its intensity and in its chromatic characteristics.

It is presently the usual practice in the operation of an enlarging camera, for example, to turn the light source on at the beginning of the day and to allow it to burn continuously throughout the entire working day. In this manner, after a preliminary warming up period has elapsed, the light source attains a constant temperature and its intensity and chromatic characteristics become stabilized. This practice, however, reduces the useful life of the light source because in burning continuously, it burns needlessly for many hours during which it is not in actual use. In this manner, many hours of its limited useful life are wasted for the sole purpose of avoiding the need for a warming up period each time that the light source is used, the warming up period being required for the light source to attain stability in its illumination intensity and chromatic characteristics.

In accordance with the present invention, the light source is enclosed in a housing which is provided with a thermostatically controlled heater and with heat distribution means whereby the lamp, when not in use, will remain pre-heated while it is shut off. Because of the constant temperature heating arrangement combined with its uniform heat distribution feature, after the heater has been turned on for an appropriate warming up period, the light source is always pre-heated ready for immediate use and it may be turned on and off at will by the usual exposure timing switch whenever desired. By thus preheating the light source, no warming up period is needed and the usual wasteful continuous burning the light source is avoided without impairing the stability of its characteristics. As a result, the light source is burned only during actual use. While the life of the light source as measured in actual burning hours is not extended, its life in terms of working days is increased tremendously because there is no burning time which is wasted, the lamp being turned on only during actual exposure of the photosensitive material in the enlarging camera or other photographic apparatus.

Generally, the light source of the present invention comprises a serpentine grid-like cold cathode fluorescent tube, a housing having a window in which the tube is arranged, a thermally conductive heat distribution plate disposed immediately behind the tube, electrical heating means mounted on the back of the heat distribution plate, and a thermostat arranged to control the heating means so that the heat distribution plate is maintained at a constant predetermined operating temperature. Separate energizing circuits are provided for the electrical heater and for the cold cathode tube. This arrangement permits the heater to operate continuously throughout the working day independently of the lamp itself so that the light source is always ready for immediate use. The fluorescent tube of the light source, however, is turned on and off by the exposure timing switch as and when required for photographic purposes and is never burned needlessly.

Various objects, features and other advantages of the invention will become apparent upon reading the following specification together with the accompanying drawing forming a part hereof.

Referring to the drawing:

FIGURE 1 is a bottom or front plan view of a light source in accordance with the invention, looking at the serpentine tube with the glass window of the housing removed.

FIGURE 2 is a top or rear plan view of the light source shown in FIG. 1, with the cover of the housing removed, and looking at the back of a heat distribution plate which is disposed behind the serpentine tube.

FIGURE 3 is a sectional view on a reduced scale taken along the line 3—3 in FIG. 1 and FIG. 2, looking in the direction of the arrows.

FIGURE 4 is an enlarged side elevational view of a thermostat switch which controls heaters for maintaining the heat distribution plate at a constant operating temperature.

FIGURE 5 is an electrical circuit diagram of the light source shown in FIGS. 1, 2 and 3.

Referring to FIG. 1, an elongated convoluted cold cathode fluorescent tube **10** of serpentine shape is mounted on a partition **11**, preferably of sheet steel, by means of four spring clips **12**. The partition **11** forms a part of a sheet metal housing designated generally as **13**. Preferably the front side of the partition **11** is provided with a matt white light diffusing surface. When the light source is used with an enlarging camera, the light will ordinarily be directed downwardly so that the light source is positioned as shown in FIG. 3. In other instances, it may be positioned so that FIG. 1 is a front view instead of a bottom view. It is to be understood that the light source may be mounted in any desired position depending upon the specific requirements of the particular photographic apparatus with which it is used.

As shown in FIG. 3 the front or bottom of the light source is provided with a glass window **15** which is mounted in a frame **16**. The tube **10** because of its continuous and convoluted shape, emits light through the window **15** substantially uniformly throughout the area of the window. The tube **10** extends over the planar area of the partition **11**, being spaced at a constant distance therefrom. The window frame **16** is removably secured to the housing **13** by suitable fastening means such as screws (not shown). This permits convenient removal and replacement of the serpentine tube **10**. The ends **17** and **18** of the tube **10** are bent to project through the partition **11** into the rear portion of the housing **13** which is located behind the partition **11**. The electrodes are located within the ends **17** and **18** of the tube **10**.

A step-up transformer designated generally as **20** is provided for energizing the tube **10**. A heat distribution plate **21** is secured to the back of the partition **11**. The heat distribution plate **21** is formed of highly thermally conductive material such as aluminum, for example. The transformer **20** is provided with mounting feet **22** which are secured to the partition **11** by bolts **23** passing through the heat distribution plate **21** and partition **11**, thus securing both the transformer **20** and heat distribution plate **21** to the partition **11**. One face of the core **25** of the transformer **20** is disposed in close proximity to and preferably in contact with the heat distribution plate **21** for heat transfer between the transformer **20** and the heat distribution plate **21**.

Two heating elements **26** are mounted on the heat distribution plate **21** by means of screws **27**. The heating

elements 26 are provided with terminals 29 and 30 which are connected in multiple by conductors 31 and 32, respectively.

A thermostatic switch 33 is mounted on the heat distribution plate 21 by means of a screw 34. The temperature responsive control switch 33 comprises cooperating long and short contact springs 36 and 37, respectively, as shown in FIG. 4. The contact springs 36 and 37 are both insulated from each other and from ground by insulating washers 38 between which they are clamped by the screw 34. The longer spring 36 is tensioned against a suitably insulated stud 39 carried at the free end of a bimetallic strip 40. Variations in the warping of the bimetallic strip 40 accompanying temperature changes produce corresponding variations in the flexure of the longer contact spring 36. The shorter contact spring 37 is tensioned against a suitably insulated adjustment stud 41. The position of stud 41 may be varied by turning a temperature adjustment screw 42. The temperature adjustment screw 42 is threadedly mounted in a fixed supporting bushing 43. The threaded bushing 43 is carried at the end of a fixed rigid supporting arm 44 which is located above the uppermost of the insulating washers 38. The bimetallic strip 40 is secured between the lowermost of the insulating washers 38 and a thermally conductive washer 45 for heat transfer between the temperature-sensitive bimetallic strip 40 and the heat distribution plate 21. The contact springs 36 and 37 are provided with cooperating contact points 45 and 46, respectively, which are serially included in the energizing circuit of the heaters 26, described in greater detail below.

From the foregoing, it will be observed that the insulated actuating stud 39 will be displaced in accordance with temperature variations of the heat distribution plate 21 and that upon attainment by the plate 21 of a predetermined operating temperature, the contact points 45 and 46 will be separated from each other and the circuit of the heating elements 26 will be opened. After the heating elements 26 and the heat distribution plate 21 have cooled off somewhat, the contact points 45 and 46 will again engage each other to re-energize the heating elements 26, thus maintaining the heat distribution plate 21 at a predetermined constant operating temperature. This constant operating temperature of plate 21 is so selected that the tube 10, throughout its entire useful light emitting length, will be maintained in a suitably pre-heated condition such that no warming up interval is required before the light emission characteristics of the tube become stabilized.

FIG. 5 shows the circuit diagram of the light source. The primary winding 48 of transformer 20 is connected by a flexible two-conductor cord 49 to an attachment plug cap 50. The plug 50 is adapted to be inserted in a suitable receptacle associated with an exposure timing switch (not shown). Such switches are conventional and, for this reason, none has been shown in the drawing. The secondary winding 51 of transformer 20 is connected directly to the electrode terminals at the ends 17, 18 of the serpentine tube 10. The energization of tube 10 is thus suitably controlled by the exposure timing switch, or other switch.

The heater circuit is provided with an attachment plug cap 53 adapted to be plugged into a suitable commercial power supply outlet. A conductor 54 extends from one terminal of plug 53 directly to heater terminal 30 of one heating element 26 and through the conductor 32 to terminal 30 of the other heating element 26. Another conductor 55 extends from the plug 53 to a toggle switch 56 which is used for turning the heater circuit on at the beginning of each working day and shutting it off when work is finished at the end of the day. From toggle switch 56, the heater energizing circuit extends via a conductor 57 to one side of the thermally responsive control switch 33. The other side of the thermal switch 33 is connected to conductor 31 which connects the two terminals 29 of the two heater elements 26 in multiple.

In operation, switch 56 is closed some time before actual use of the light source is desired. The heater elements 26 are thus energized and de-energized by the thermal switch 33 so that the heat distribution plate 21 is brought up to and maintained at its predetermined operating temperature. Once the heat distribution plate 21 is at its correct operating temperature, tube 10 is maintained in a pre-heated condition ready for immediate use by actuation of the exposure timing switch or other switch controlling the energization of plug 50. The transformer 20, which is mounted on the heat distribution plate 21, is also maintained in a pre-heated condition like the tube 10. Accordingly, the resistances of its windings will be maintained at values near the values which they attain under load conditions. The transformer 20 is thus ready for immediate operation without any warming up period.

The thermal switch 33 will not call for heat if the heat distributing plate 21 is maintained in a heated condition by heat generated by operation of the tube 10. When tube 10 is shut off, however, the thermal switch 33 and heaters 26 prevent the temperature of distribution plate 21 from dropping below its predetermined operating temperature, the tube 10 thus being maintained at a predetermined minimum pre-heating temperature. The heat distribution plate 21 distributes the heat uniformly to the tube 10 through the thermally conductive sheet metal partition 11. The tube 10 is thus located in a closed and uniformly heated compartment 58 (FIG. 3) defined by the front window glass 15, the metal partition 11 and the sides of the housing 13. All longitudinal portions of the tube 10 which emit useful light are disposed in the compartment 58 and are thus maintained uniformly pre-heated at the same initial temperature so that performance of the tube 10 will be the same, both as to intensity and chomatic characteristics, whenever the tube 10 is energized.

While I have shown what I believe to be the best embodiments of my invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A light source comprising, in combination, an elongated cold cathode tube having convolutions formed therein, said tube being spaced at a constant distance from and extending over a predetermined planar area for emitting light substantially uniformly throughout said area, a controllable energizing circuit for said tube, electric heating means, thermally conductive substantially planar heat distribution means spaced from and extending parallel to said tube, said distribution means being substantially coextensive with said area and being disposed to transmit heat from said heating means to said tube uniformly along said tube and over said area, an energizing circuit for said heating means separate from said first-named energizing circuit, and thermally responsive switch means included in said energizing circuit for said heating means, said switch means controlling said heating means to maintain said tube at a predetermined constant minimum temperature when said tube is de-energized.

2. A light source comprising, a housing, a window in said housing, a continuous elongated cold cathode tube having a plurality of convolutions formed therein arranged behind said window to emit light therethrough substantially uniformly throughout the area thereof, a thermally conductive partition disposed in said housing behind said tube, said tube being confined in a closed compartment defined by said window, said partition and said housing, an energizing circuit for said tube, said energizing circuit including a transformer disposed in said

housing behind said partition, constant temperature heating means separate from said transformer disposed in said housing behind said partition, heat distributing means connecting said heating means for heat transfer to said partition uniformly throughout the area thereof for maintaining said tube uniformly heated throughout its length, and thermostat means responsive to the temperature of distributing means and controlling said heating means for maintaining said tube at a predetermined minimum temperature when said energizing circuit is de-energized.

3. A light source comprising, a housing, a window in said housing, a thermally conductive partition disposed behind and spaced from said window, the front surface of said partition having diffusive light reflecting characteristics, said window, said partition and said housing defining a closed compartment, an elongated cold cathode fluorescent tube disposed in said compartment, a thermally conductive plate fixed to the rear face of said partition, heating means independent of said tube connected to said plate, and thermostat means responsive to the temperature of said plate and connected to control said heating means for maintaining said tube at a predetermined minimum temperature when said tube is deenergized.

4. A light source for photographic use comprising, a housing having side walls, said housing being open at its front and closed at its rear; a window closing the front of said housing; a thermally conductive flat partition disposed behind said window and defining with said window and said side walls a closed compartment, the front side of said partition having a matt white light diffusing surface; a flat thermally conductive heat distribution plate fixed to the rear face of said partition; electrical heating means fixed to the rear face of said heat distribution plate, said plate transferring heat in a uniformly distributed manner from said heating means to said partition; an energizing circuit for said heating means; thermally responsive switch means included in said energizing circuit, said switch means being responsive to the temperature of said plate for maintaining said plate at a predetermined fixed operating temperature; an elongated cold cathode fluorescent tube having a useful light-emitting portion thereof disposed in said compartment; and a separate energizing circuit for said tube controllable

independently of said energizing circuit for said heating means.

5. A light source according to claim 4, further comprising a transformer included in said separate energizing circuit, said transformer being mounted on said plate to be maintained at a constant minimum temperature when said tube is de-energized.

6. A light source according to claim 4, in which said useful light emitting portion of said tube is of serpentine configuration said tube having end portions which extend through said partition into said housing and into a portion of said housing which is external to said compartment, said useful light emitting portion being adapted to be maintained uniformly pre-heated throughout its length at a predetermined minimum temperature when said tube is deenergized.

7. A photographic light source of high intensity and stability comprising: an elongated cold cathode tube normally requiring a warming-up period before it is ready for use, heat distribution means disposed in thermally conductive proximity to said tube for evenly distributing heat throughout the length of said tube, constant temperature electrical heating means disposed in thermally conductive relationship with respect to said heat distribution means for maintaining said heat distribution means at a predetermined temperature whereby said tube is heated to a temperature such that said warming-up period is effectively eliminated, and a separate energizing circuit for said heating means whereby said tube may be maintained at said last-named temperature when not in use.

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